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September 28, 1973
File: 3539-A9270

Environmental Protection Service
Environment Canada
Imperial Oil Building
Edmonton, Alberta

Attention: Mr. J.W. Grainge, P.Eng.
Head, Arctic Technology Group

Dear Sir:

Re: Buried Utilities - Happy Valley - Inuvik

We are pleased to submit this brief letter report in response to your request for background information on the proposed use of buried utilities in the Happy Valley area of Inuvik.

SITE

The Happy Valley area was subdivided in November 1971 (legal plan CLSR 57309) as shown on the enclosed plan. Basically there is an access road, 15 residential sized lots (numbered 1 to 15) and one large unsubdivided area (numbered 16). This survey does not make optimum use of the available land from either a land use or a utility serviceability point of view. We have sketched additional lots onto the existing survey to show how 13 more lots can be added to obtain maximum utilization of both the area and the proposed utility installation.

Although not shown, we recommend that any resurvey of the area include a utilities right-of-way. This will allow unlimited access for repair crews and for your instrumentation personnel.

The soils in Happy Valley appear to be among the best in the Inuvik area from a residential development point of view. As shown on Figure 1 (attached) the soils are gravel with some sand, or silt under less than 2 feet of peat. Additional details on soil conditions, ground temperatures, etc. can be obtained from the NRC Technical Paper 135, "Inuvik N.W.T., Engineering Site Information", dated August 1962. However, due to the unique nature of the proposed installation, we feel that a minimum of 6 soil test holes should be drilled along the utility right-of-way. This will cost approximately $1200 if done by a geotechnical consulting firm.

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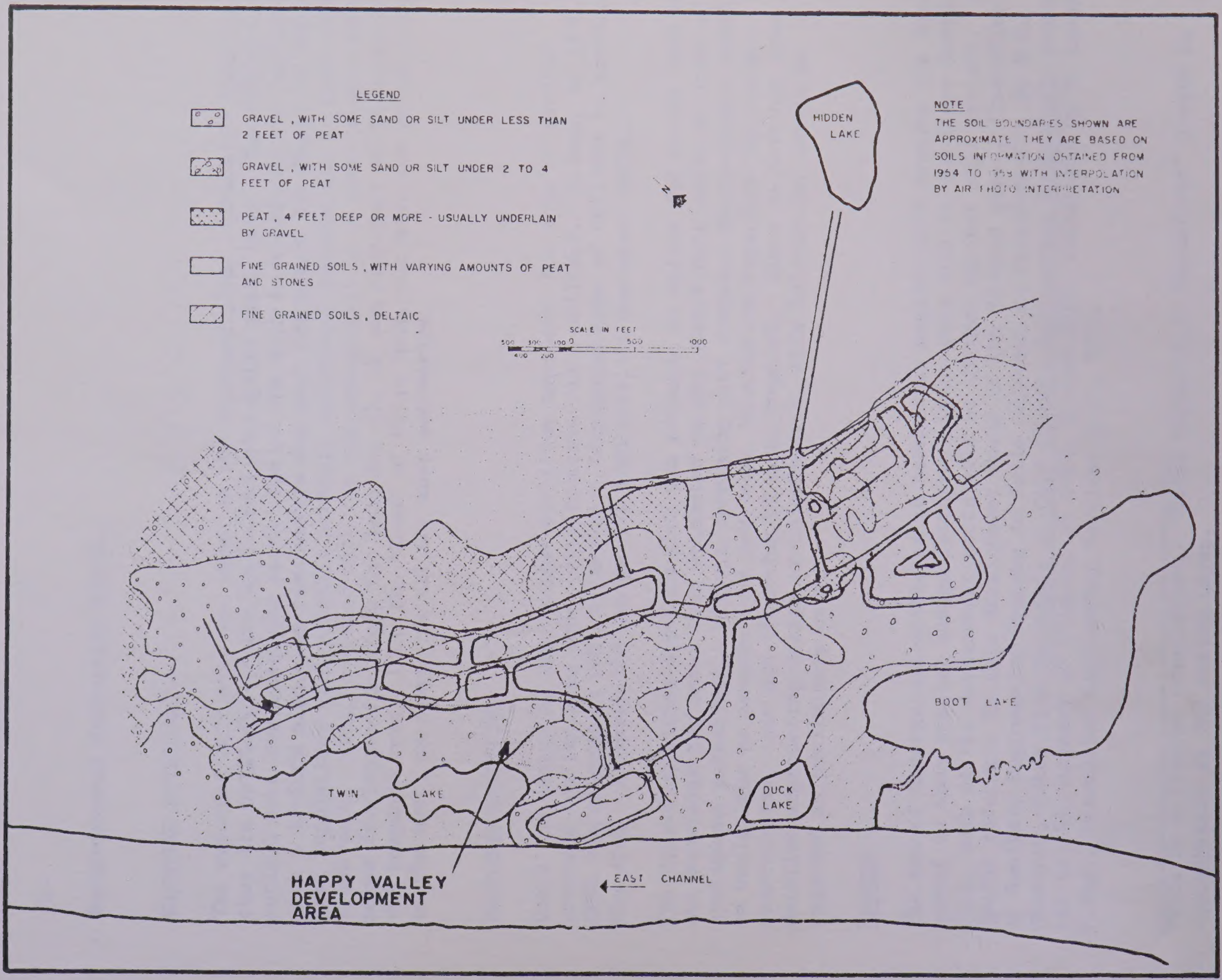
LEGEND
GRAVEL , WITH SOME SAND OR SILT UNDER LESS THAN 2 FEET OF PEAT
GRAVEL , WITH SOME SAND OR SILT UNDER 2 TO 4 FEET OF PEAT
PEAT , 4 FEET DEEP OR MORE - USUALLY UNDERLAIN BY GRAVEL
FINE GRAINED SOILS , WITH VARYING AMOUNTS OF PEAT AND STONES
FINE GRAINED SOILS , DELTAIC
SCALE IN FEET
500
400
300
200
100
0
500
1000
N
NOTE
THE SOIL BOUNDARIES SHOWN ARE APPROXIMATE. THEY ARE BASED ON SOILS INFORMATION OBTAINED FROM 1954 TO 1958 WITH INTERPOLATION BY AIR PHOTO INTERPRETATION
HIDDEN LAKE
BOOT LAKE
DUCK LAKE
TWIN LAKE
HAPPY VALLEY DEVELOPMENT AREA
EAST CHANNEL

Adapted from NRC Tech. Paper #135

INUVIK, SOILS DISTRIBUTION *Figure #1*

EXISTING UTILITIES

The existing utilities are shown on the enclosed plan. Generally speaking, they are utilidors of the half round corrugated metal type. The 8-inch sewer outfall main bordering the south side of the area is scheduled for replacement with a 12-inch pipe, sometime within the next few years. It should be noted that regulations will probably prohibit individual connections to this outfall trunk main. This, combined with the inaccessability to a water supply main, makes development unlikely for Lots 14, 15, 17 and that part of 16 south of the proposed road. With the "loss" of these lots, the addition of the 13 lots to the west, as shown, is all the more attractive.

PROPOSED UTILITIES

Until the advent of your buried utilities approach, the type of service proposed for the area under consideration was a utilidor. Indeed, in 1970, AESL was engaged by NCPC to design a corrugated type of utilidor to service the area. Although the design was completed, it was never built.

The buried utilities approach that you advocate is unique and to the best of our knowledge has never been attempted on any significant scale in areas of continuous permafrost. Without examining your computer thermodynamic model, we would like to present some pertinent information regarding the design, construction, cost and financing of your proposal. Since we have not done any detailed engineering design or calculations, this information should be regarded as preliminary only.

Design

The use of underground utilities in permafrost regions will require the development of many special design features. Since this will be the first installation, much of the development costs will be charged against this project. A useful reference in this development would be the Russian paper, "Installation of Sanitary Engineering Systems in Soils Adjacent to Permafrost"*, by B.N. Churakov, taken from Materials on Cold Climate Engineering Technology, pages 144 to 151, Academy of Sciences of USSR, Moscow 1959, translated by P. Lukomskyj, P.Eng., Associated Engineering Services Ltd., 1973.

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*This is a literal translation. "Soils Adjacent to Permafrost" should be interpreted as the Active Layer.

.../3

Examples of some of the special technical aspects which will have to be considered are:

1. What is the optimum depth of bury? A deep bury will result in uncertainties in operation, will be difficult to install and to repair. Initial analysis indicates that a relatively shallow bury would be best and perhaps the first installation should be in a berm.

2. A shallow depth installation with its special structural and thermodynamic considerations will require the use of special pipe. The piping should ideally be prefabricated in a rigid conduit and insulated with a hydrophobic type of insulation. The "U-Dor" rigid piping conduit (Figure 2) as marketed by Fiberlite Products of Edmonton appears to be worthy of careful consideration. Particular attention should be given to the use of strong pipe with rigid joints such as steel pipe with welded joints or equal.

3. The pipe bedding will be critical. It may be desirable to have the first installation actually supported on piles cut off below ground. The Soviet paper, mentioned above, suggests the use of transverse beams which would extend beyond the zone of potential thermal degradation to an area where they could be frozen in and thereby provide positive support to the piping conduit. The disruption of the natural regime caused by the excavation and the physical presence of the piping conduit will provide a drainage course. Therefore, the soil around the piping should have the least possible porosity since coarse grained soils when fully saturated are as much subject to swelling when frozen as the silty or clayey soils. It may also prove advantageous to install impermeable barriers of soil cement around the conduit at selected intervals to prevent large scale migration of moisture. Where moisture will be a problem, perhaps drainage troughs should be placed along the bottom of the conduit to drain away any excess accumulation of water.

4. Special design consideration will have to be given to hydrants and sewer manholes which will penetrate the soil cover and will be subject to both the active layer "jacking" forces and the low ambient air temperatures.

5. The entire system should be placed on a grade so that it is drainable if special emergency conditions arise.

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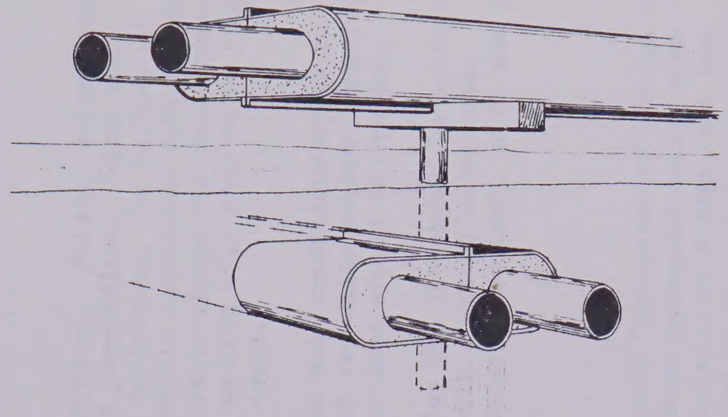
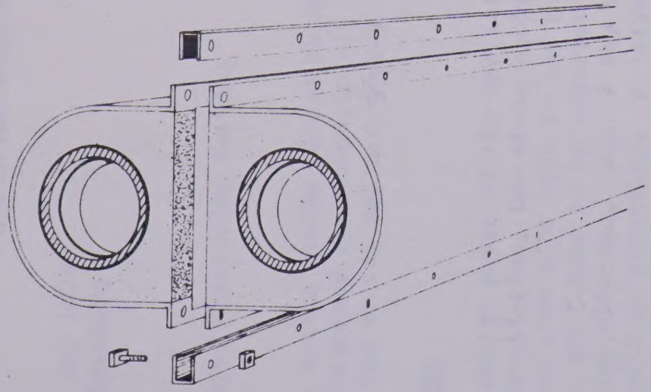
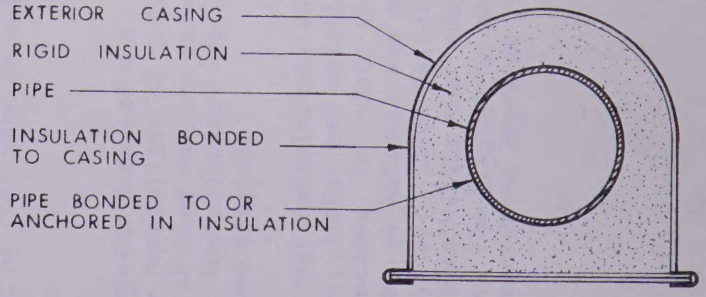


U-DOR SHOWING ABOVE AND BELOW GROUND INSTALLATIONS



U-DOR ASSEMBLY WATER & SEWER MAINS


EXTERIOR CASING
RIGID INSULATION
PIPE
INSULATION BONDED TO CASING
PIPE BONDED TO OR ANCHORED IN INSULATION

BASIC U-DOR UNIT WATER SUPPLY & SEWER OUTFALL MAINS

U – DOR UTILIDOR
(MANUFACTURED BY: FIBERLITE PRODUCTS CO. LTD., EDMONTON)

FIGURE No. 2

6. The entire system should be heat traced. The operating switch should incorporate an automatic off feature to avoid excess heat loss problems if the switch was accidently left on for a prolonged period of time.

Construction

The construction phase of the project will be critical. Without exceptional care in installation, the whole project could be jeopardized. Since the construction crew will have to use many special techniques, the caliber of the workmen will have to be superior to that normally associated with a water and sewer installation. One of the most significant, though not insurmountable problems, will be trenching. A large hydraulic backhoe will have to be brought to Inuvik for this job (resulting in additional cost).

The timing of the project will be important. The best conditions would be in late fall when the ground is still thawed, but the daily ambient temperatures are low. Excavation during the long, warm summer days should be avoided.

Due to the special nature of the project, bids for the job should be solicited by invitation from selected construction firms with a strong background. Alternatively, it may prove advantageous to negotiate a contract or do the job on some sort of cost plus arrangement.

Cost

The buried system proposed will have to be of a very "conservative" design to minimize the possibility of failure. This will mean increased design time and the use of high quality materials. The result will be a high cost for this pioneer installation. This will be compounded by the relatively small footage of the project.

Preliminary cost calculations were made by estimating the total cost per day for equipment, labour and materials and then adding 30% for engineering and contingencies. To reduce this daily cost to a cost per foot of the buried system, an estimate was made of the number of feet which could be installed per day. These calculations are shown in Appendix A. There is a very good possibility that contract prices will amount to more than the estimate since the project is unique and there will be a natural tendency for the Contractor to increase prices to account for unforeseen difficulties.

.../5

It does appear that the proposed buried system could be built for about the same cost as a utilidor of the current plywood box variety. However, utilidor prices are more certain than buried utility prices. For this reason and the fact that the developers of Happy Valley will regard the buried system approach as "experimental" versus the established utilidor approach, the tendency will be to remain with utilidors as a means of water and sewer servicing.

Financing

Since the Happy Valley Development is a co-operative venture without heavy government financial support, it is unrealistc to expect acceptance of a buried system which is without precedent and which will cost more than the locally accepted means of utility service. It is imperative, therefore, that Environment Canada be prepared to make a substantial financial commitment to the installation. Perhaps the most convenient arrangement would be to have Environment Canada build the system and monitor/maintain it for one or two years after which they would turn it over to the local authorities for a cost which would be slightly less than the equivalent utilidor would have cost.

CONCLUSION

The immediate problem facing the adoption of a buried utilities system in Inuvik is not technical, but financial. The Arctic Technology Group of Environment Canada cannot expect the acceptance of the concept unless they make a major financial commitment towards construction. This should be resolved as soon as possible and the co-operative development group consulted.

The Happy Valley area should be resurveyed to include 13 additional lots as shown on the enclosed plan. A soils test program should be initiated immediately. The design and construction techniques will have to be conservative to guarantee trouble free performance.

.../6

The buried utilities approach appears to be viable and the Happy Vallev area of Inuvik provides an ideal location for the first installation.

Yours truly,

ASSOCIATED ENGINEERING SERVICES LTD.

D. J. Gamble.

D.J. Gamble, M.Sc. P.Eng.
Project Engineer

E.I. Carefoot, P.Eng.
Chief, Northern Projects

/dsa

APPENDIX A

COST ESTIMATE

CO-OP UNDERGROUND UTILITIES - ESTIMATE

Estimate Based on Cost of One Day's Work on Project

One Day's Work (Typical)

A. EQUIPMENT

Based on Alberta Roadbuilders Association rates, plus 25% for NWT.

Cat:	Clearing and work with ripper or equivalent: 2 hr at $32.00/hr	$ 64.00
Loader:	To backfill trench, cleanup, etc.: 2 hr at $18.75/hr	38.00
Backhoe:	To excavate trench: 12 hr at $36.25/hr	435.00
Grader:	For final cleanup: 1 hr at $25.00/hr	25.00
	TOTAL: Equipment	$ 562.00

B. LABOUR

Including room and board, etc.

1	Foreman at $15.00/hr x 12 hr/day	$ 180.00
2	Pipelayers at $12.00/hr x 12 hr/day	288.00
3	Labourers at $10.00/hr x 12 hr/day	360.00
	TOTAL: Labour	$ 828.00

C. MATERIALS

Granular fill (or equivalent):	0.75 cu yd/ft x $5.00/yd in-situ	$ 4.13/ft
Piping:	including all fittings, hydrants, etc. prefabricated such as the "U-Dor" concept FOB Inuvik - approximately	55.00/ft
	TOTAL: Materials	$ 60.00/ft

D. ENGINEERING AND CONTINGENCIES

D = 30% x (A + B + C)

Therefore, TOTAL COST PER DAY:

Equation 1: $[562 + 828 + x(60)]1.3$

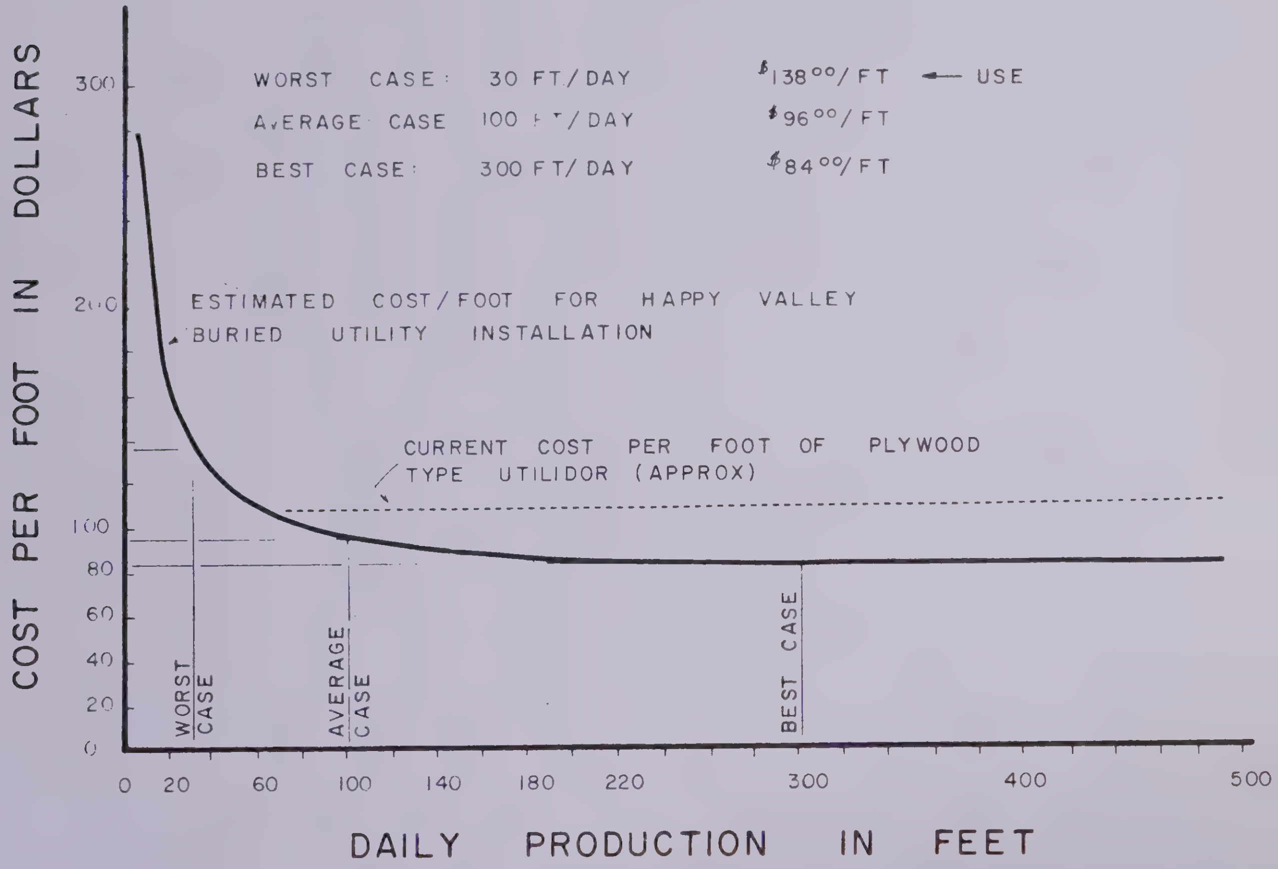
where x is the number of feet of pipe installed per day.

TOTAL COST PER FOOT:

Equation 2: $[\frac{1390}{x} + 60]1.3$

The daily production of the construction crew will depend to a large degree on the results of the soils tests, the nature of the design and the season of construction.

From Equation 1, the graph of cost versus daily production can be drawn.



It must be noted that the above costs are estimates for a pioneer installation. Subsequent installations would probably be cheaper. Nonetheless, it shows that underground utilities can realize savings of up to $30.00 per foot when compared to utilidors. This does not account for the decreased cost of the buried system resulting from lower maintenance, longer life and elimination of utilidor road crossings, etc.

This shows the tremendous potential of the buried utilities approach.

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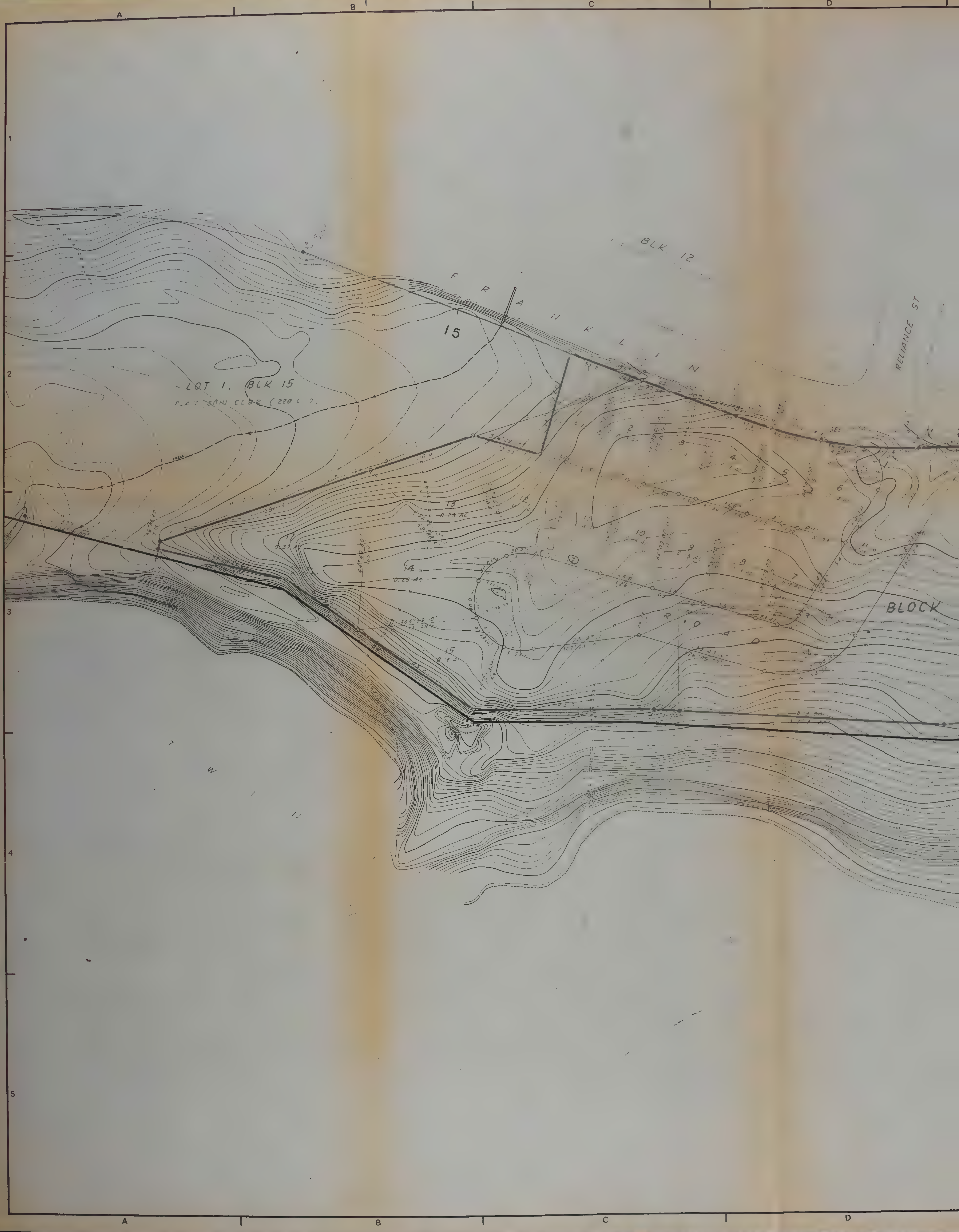
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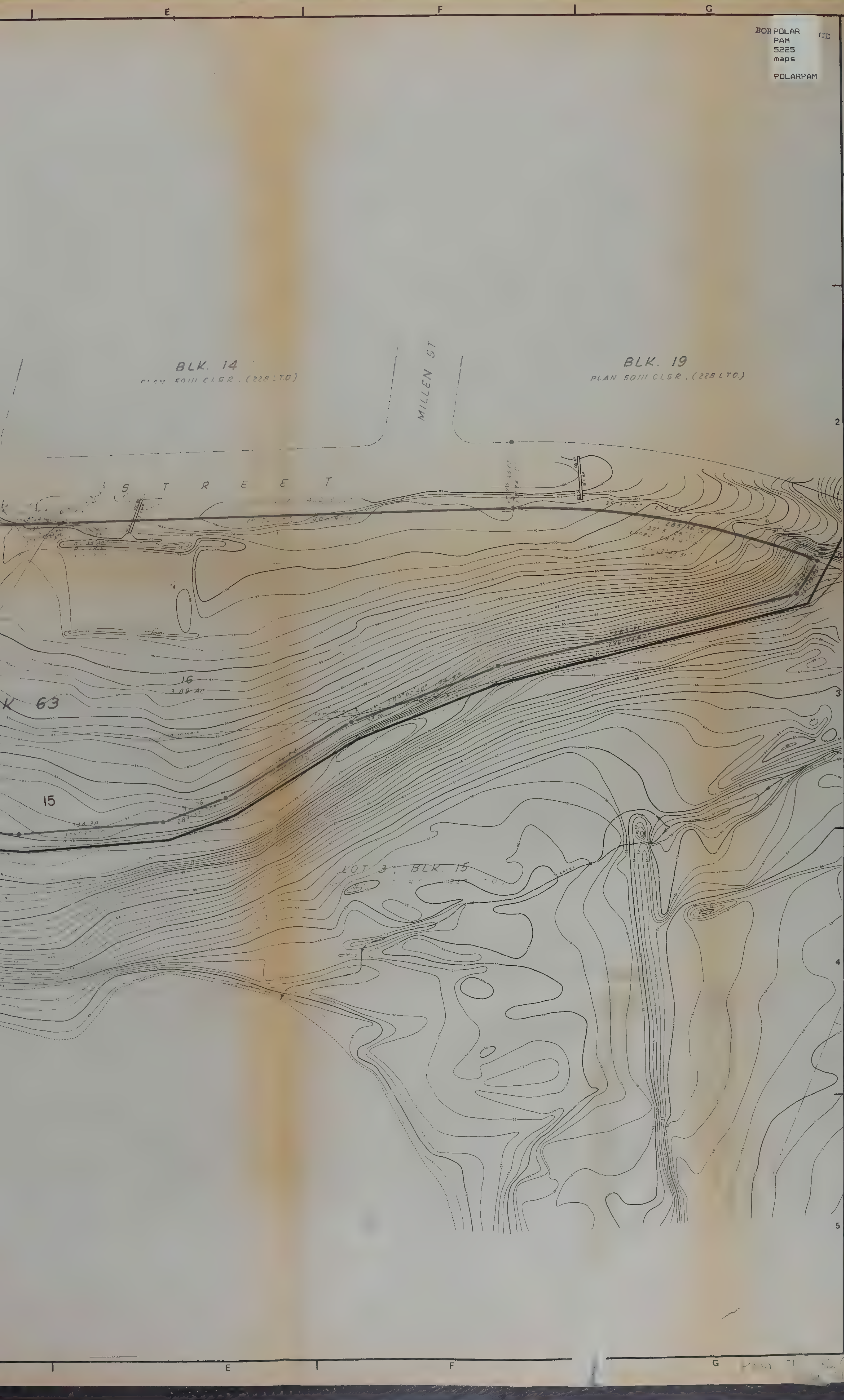

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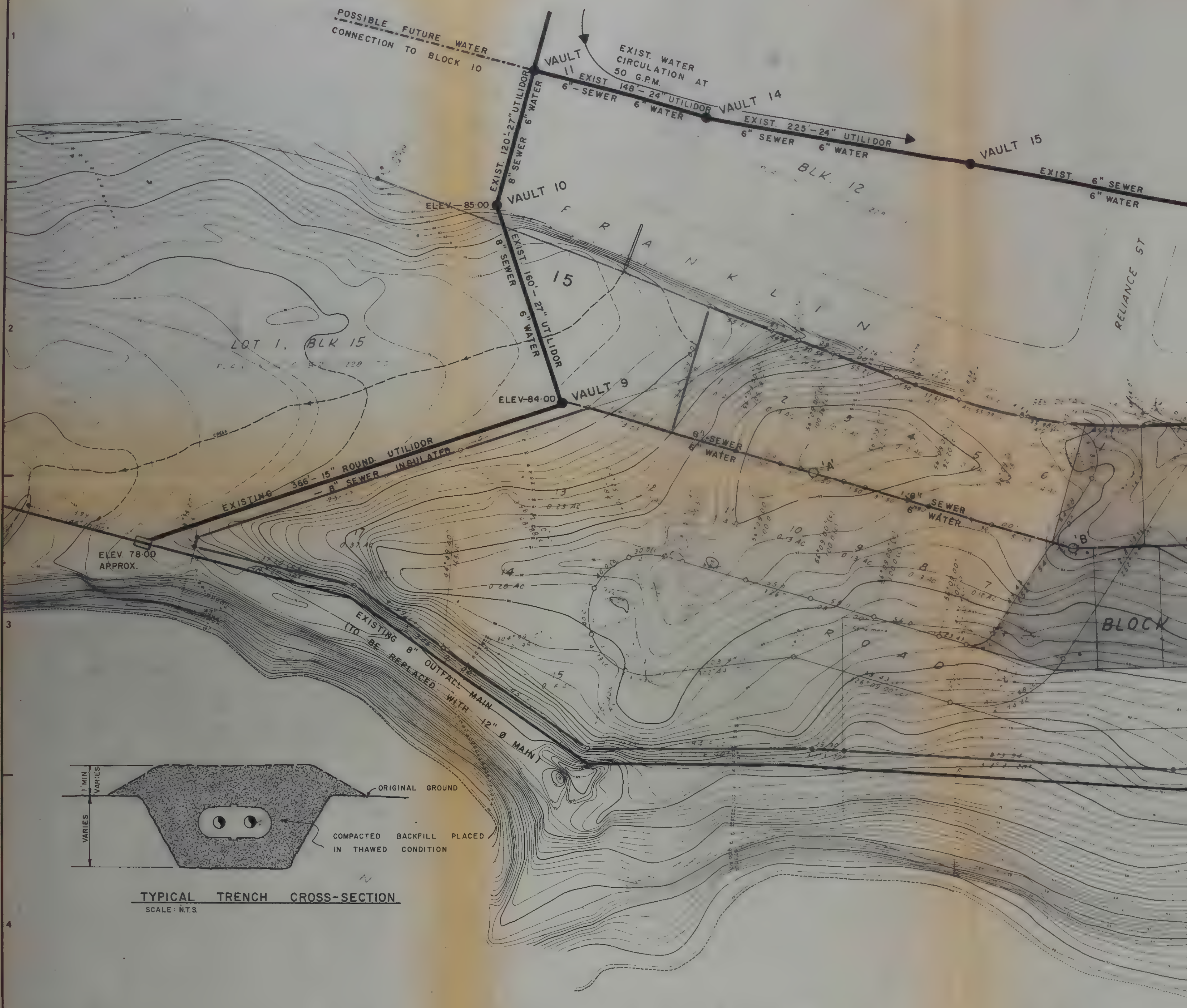

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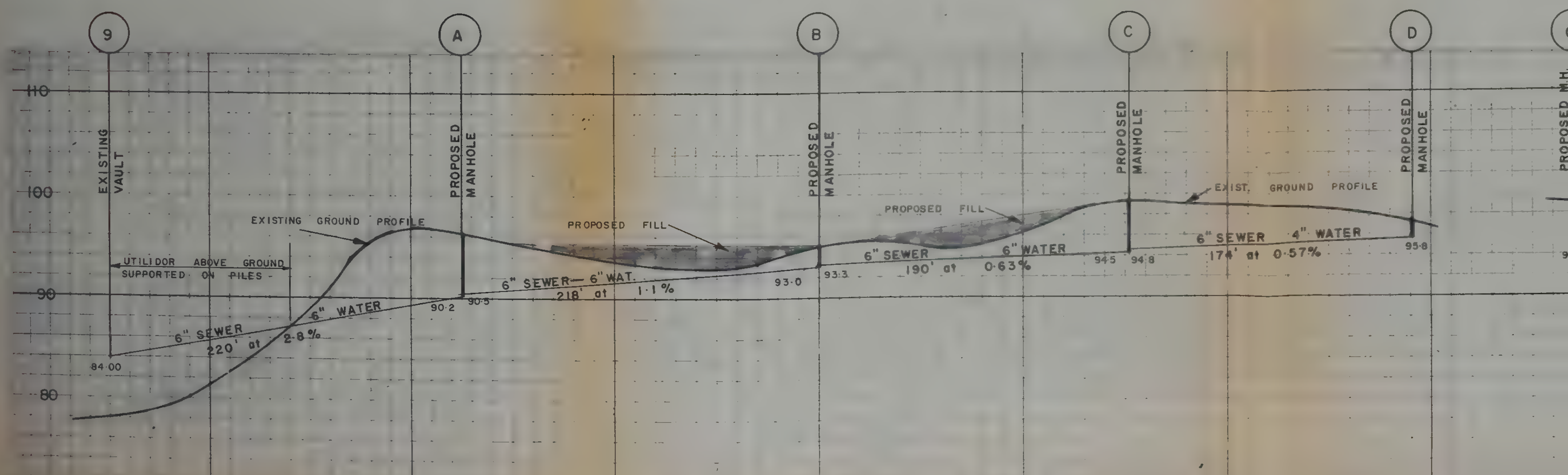

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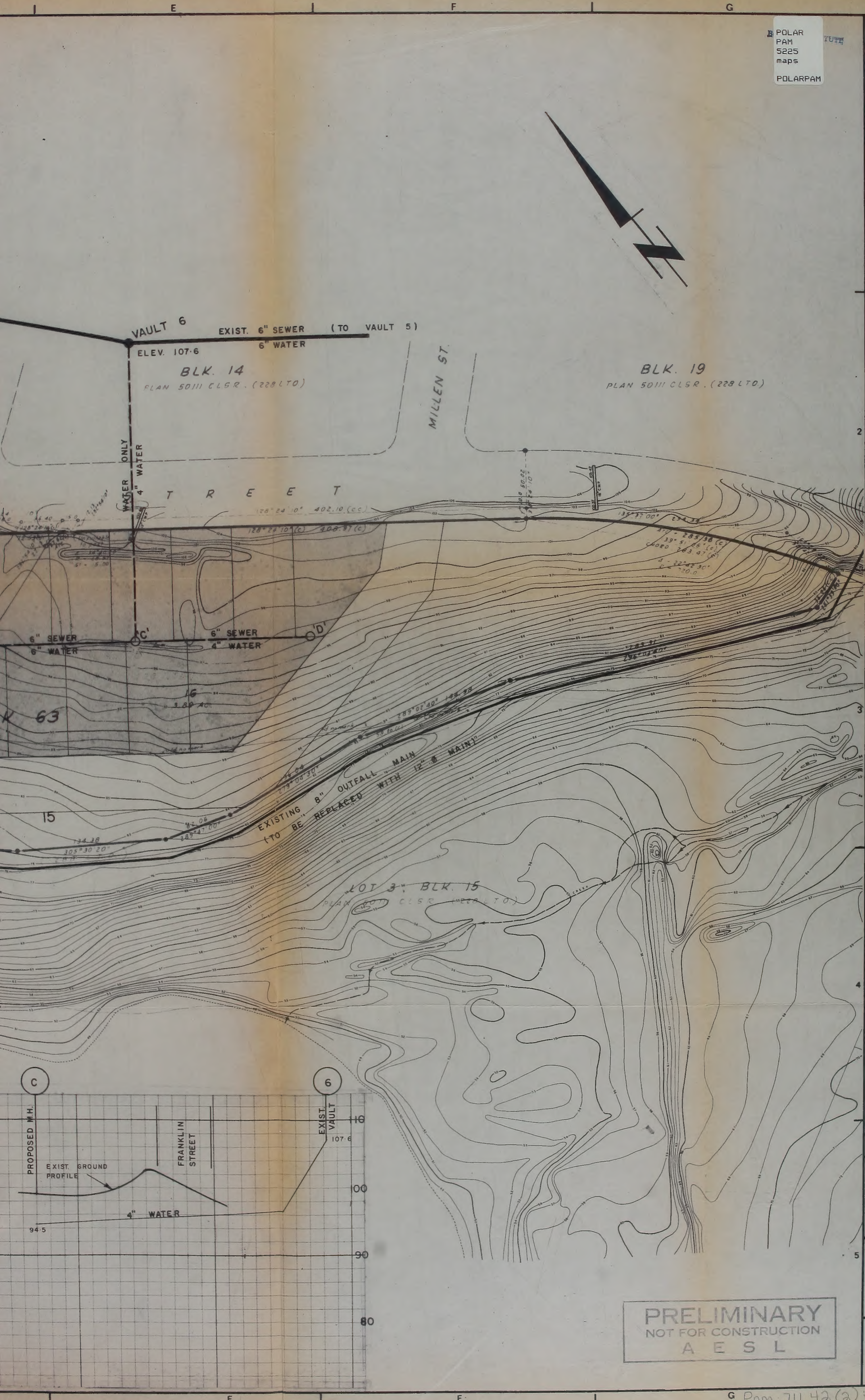

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